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FL11 Luo FL11
Kikuyu FL10

I.—Blood Groups in some Kenya Tribes

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This communication embodies the results of A,A$_2$BO, MNS, and Rh tests on the Luo and Kikuyu tribes of Kenya, together with P tests on the Kikuyu and ABO tests on the Masai. The specimens were collected as part of the anthropological investigation carried out while one author (A.C.A.) was a member of the Oxford University Mount Kenya Expedition, 1949.

The only previous anthropological blood group study carried out in this area is the work of Elsdon-Dew (1939) on the ABO groups of some East African native populations.

The Luo and Kikuyu are two of the largest tribes in the country and although neither is "racially pure" they differ in language and custom and are generally believed to differ in origin. The Luo may be taken as representative of the Nilotic group and the Kikuyu of the Eastern Bantu.

The subjects were hospital patients and groups of labourers, the Luo from Nairobi and Nakuru districts, the Kikuyu from Nairobi, Kiamba and Embu districts. Individuals who were tested were unrelated to one another and were not aware of having any forebears from other tribes. Specimens were taken in the form of clotted blood by means of "Venules" and sent by air to London. Specimens were taken without mishap or complication from 128 Luo and 124 Kikuyu. Specimens were also taken from a further 61 Luo and 111 Kikuyu, but owing to an unsatisfactory system of labelling became mixed in transit. As will be shown below, the Luo and the Kikuyu differ little in their blood group frequencies and the mixed specimens differ little from either of the pure batches. Moreover, the total number of

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MNS and Rh tests recorded for Africans is very small. It has therefore been thought desirable to place on record the results of our tests on these mixed specimens as representing a general and not highly heterogeneous sample of the East African native population.

The specimens arrived in London in good condition in about three days. Tests for the ABO system were done with anti-A, anti-A_1 and anti-B. Rh tests were done with anti-C, anti-D, anti-E and anti-c. All E positive bloods were tested with anti-e, and all bloods negative with saline anti-D were tested for the D^u antigen by means of an indirect Coombs test with "incomplete" or albumin-agglutinating anti-D. Dr. K. Henningsen, of Copenhagen, was visiting the Laboratory and tested 66 Kikuyu bloods for P by the elaborate and highly accurate method which he has devised for detecting this difficult antigen, with results which he has recently published (Henningsen, 1950). In addition, ABO grouping was carried out in the field near Magadi on 233 Masai tribesmen.

The methods used in the gene frequency calculations are based on the accepted theories of the genetics of the respective blood group systems, which are conveniently set out in the chapters on the various systems by Race and Sanger (1950). The details of the methods are too complicated to set out within the limits of a paper such as this, but will shortly be published in full by Mourant (1953).

For the ABO system the methods are based on the corrected method of Bernstein (1930). For the MNS system the total frequencies of the M and N genes are calculated by the gene adding method (e.g. $\overline{M} = \overline{MM} + \frac{1}{2}\overline{MN}$) and the total S frequency thus:

$$\overline{S} = 1 - \sqrt{MsMs + MsNs + NsNs}$$

This value for $\overline{S}$ is then divided up between $\overline{MS}$ and $\overline{NS}$ in proportion to values for $\overline{MS}$ and $\overline{NS}$ derived separately from the values of $\overline{MMS}$ and $\overline{MsMs}$; and of $\overline{NNS}$ and $\overline{NsNs}$.

For the Rh system the total frequency of the C

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gene (which is the sum of the frequencies of the chromosomes carrying C) is obtained by gene adding methods:

$$\overline{C} = \overline{CC} + \tfrac{1}{2}\overline{Cc}$$

$\overline{E}$ is obtained similarly.

If, as in all these samples, recognizable genotypes containing CDE and CdE are absent, then:

$$\overline{cde} + \overline{cD^{e}e} + \overline{cDe} = 1 - (\overline{C} + \overline{E})$$

Provisional separate values for these three chromosome frequencies are obtained by square root formulae involving the frequencies of the phenotypes ccddee, $ccD^{e}ee$ and ccDee, and the resultant values are adjusted proportionally so that their sum is that already obtained. The frequencies of the rarer chromosomes are then obtained from these basic values by further equations based on the simple genetical rules, e.g.

$$Cde = \frac{\overline{Ccddee}}{2\ cde}$$

In certain cases, such as that of the Luo, it has been necessary to devise further equations, based on the same principles, to meet special eventualities.

The good agreement between the observed phenotype frequencies and the expected frequencies calculated from those of the genes are evidence of the general accuracy of the serological tests and the homogeneity of the populations tested. The deficiency of AB among the Masai, as compared with the expected number, is probably due to a small number of A_2B bloods having been taken for B, an error difficult to avoid under field conditions. Since both on internal and on external evidence the mixed series of Luo and Kikuyu specimens was probably not highly heterogeneous from a blood group standpoint, and since gene frequencies are of great help in comparing one population with another, this series has been treated as though homogeneous, and gene frequencies calculated as for the others.

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TABLE I. *The ABO Blood Groups of the Luo*

Group	Number observed	Frequency observed	Frequency expected	Number expected
O	58	0·4531	0·4715	60·59
A_1	24	0·1875	0·1700	22·52
A_2	8	0·0625	0·0512	6·55
B	35	0·2734	0·2507	32·09
A_1B	3	0·0234	0·0367	4·70
A_2B	0	0·0000	0·0118	1·51
	128	0·9999	0·9999	127·96

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Gene frequencies

O	0·6881
A_1	0·1127
A_2 .. .	0·0362
B	0·1629
	0·9999

TABLE II. *The MNS Blood Group Frequencies of the Luo*

Phenotype	Number observed	Frequency observed	Frequency expected	Number expected
MMS	11	0·0859	0·0923	11·82
MsMs	19	0·1484	0·1655	21·19
MNS	28	0·2187	0·2039	26·10
MsNs	42	0·3281	0·2959	37·88
NNS	13	0·1016	0·1100	14·08
NsNs	15	0·1172	0·1323	16·93
	128	0·9999	0·9999	128·00

Chromosome frequencies

MS	0·1010
Ms	0·4068
NS	0·1285
Ns	0·3637
	1·0000

TABLE III. *The Rh Blood Group Frequencies of the Luo*

Phenotype	Commonest genotype	Number observed	Frequency observed	Frequency expected	Number expected
ccDee	R_oR_o	103	0·8047	0·8134	104·11
CcDee	R_oR'	11	0·0859	0·0766	9·81
ccDEe	R_oR''	11	0·0859	0·0766	9·81
ccD^{u}ee	R^u_or	1	0·0078	0·0062	0·79
CcD^{u}ee	R^u_oR'	1	0·0078	0·0044	0·57
ccddEe	R_r	1	0·0078	0·0039	0·50
ccD^{u}Ee	R^u_oR''	0	0·0000	0·0044	0·57
ccddee	rr	0	0·0000	0·0017	0·22
Ccddee	$R'r$	0	0·0000	0·0039	0·50
CCddee	$R'R'$	0	0·0000	0·0022	0·28
CcddEe	$R'R''$	0	0·0000	0·0044	0·56
ccddEE	$R''R''$	0	0·0000	0·0022	0·28
		128	0·9999	0·9999	128·00

Chromosome frequencies

R_o	cDe	.. ..	0·8174
R^u_o	cD^{u}e	..	0·0474
r	cde	.. ..	0·0415
R'	CDe	.. ..	0·0469
R''	cdE	.. ..	0·0469
			1·0001

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Chromosome frequencies

R_o	cDe	0·6159
R_1	CDe	0·0654
R_2	cDE	0·0645
R'	cDe	0·0942
R'	Cde	0·0313
r	cde	0·1287
		1·0000

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TABLE VII. *The ABO Blood Groups of a Mixed Series of* 61 *Luo and* 111 *Kikuyu*

Group	Number observed	Frequency observed	Frequency expected	Number expected
O	87	0·5058	0·5106	87·82
A_1	31	0·1802	0·1749	30·09
A_2	11	0·0640	0·0640	11·01
B	37	0·2151	0·2099	36·09
A_1B	4	0·0233	0·0289	4·97
A_2B	2	0·0116	0·0117	2·01
	172	1·0000	1·0000	171·99

Gene frequencies

O	.. .. ..	0·7145
A_1	.. ..	0·1077
A_2	.. ..	0·0435
B	.. .. ..	0·1342
		0·9999

TABLE VIII. *The MNS Blood Groups of a Mixed Series of* 61 *Luo and* 111 *Kikuyu*

Phenotype	Number observed	Frequency observed	Frequency expected	Number expected
MMS	29	0·1686	0·1458	25·09
MsMs	21	0·1221	0·1310	22·53
MNS	34	0·1977	0·2370	40·76
MsNs	47	0·2733	0·2616	45·00
NNS	19	0·1105	0·0939	16·15
NsNs	22	0·1279	0·1306	22·47
	172	1·0001	0·9999	172·00

Chromosome frequencies

MS	.. ..	0·1642
Ms	.. ..	0·3619
NS	.. ..	0·1124
Ns	.. ..	0·3614
		0·9999

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TABLE IX. *The Rh Blood Groups of a Mixed Series of* 61 *Luo and* 111 *Kikuyu*

Phenotype	Commonest genotype	Number observed	Frequency observed	Frequency expected	Number expected
ccDee	R_0R_0	97	0·5640	0·5793	99·65
CcDee .	R_1R_0	24	0·1395	0·1325	22·79
CCDee	R_1R_1	2	0·0116	0·0074	1·27
ccDEe	R_2R_0	35	0·2035	0·1743	29·98
ccDEE	R_2R_2	1	0·0058	0·0127	2·18
CcDEe	R_1R_2	1	0·0058	0·0194	3·33
ccD^{u}ee	R^u_0r	3	0·0174	0·0179	3·08
ccddee	rr	7	0·0407	0·0418	7·19
Ccddee	R′r	1	0·0058	0·0058	1·00
ccddEe	R″r	1	0·0058	0·0058	1·00
CcD^u e	R^u_0R'	0	0·0000	0·0011	0·20
ccD^{u}Ee	R^u_0R''	0	0·0000	0·0011	0·20
CCddee	R′R′	0	0·0000	0·0002	0·03
CcddEe	R′R″	0	0·0000	0·0004	0·07
ccddEE	R″R″	0	0·0000	0·0002	0·03
		172	0·9999	0·9999	172·00

Chromosome frequencies

R_0	cDe	0·5550
R_1	CDe	0·0730
R_2	cDE	0·0992
R^u_0	cD^{u}e ..	0·0399
r	cde	0·2045
R′	Cde	0·0142
R″	cdE	0·0142
		1·0000

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TABLE X. *The P Blood Groups of the Kikuyu*

	Number observed	Frequency
P-positive	64	0·970
P-negative	2	0·030
Total	66	1·000

Gene frequencies

P	.. .. ..	0·826
p	.. .. ..	0·174
Total	.. ..	1·000

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TABLE XI. *The ABO blood groups of the Masai*

Group	Number observed	Frequency observed	Frequency expected	Number expected
O	112	0·4807	0·5034	117·29
A	47	0·2017	0·1762	41·05
B	71	0·3047	0·2800	65·24
AB	3	0·0129	0·0403	9·40
	233	1·0000	0·9999	232·98

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Gene frequencies

O .. .. .. 0·7095
A .. .. .. 0·11[illegible]
B .. .. .. 0·1[illegible]

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TABLE XII. *Colle[illegible]requencies : Kenya*

	Kikuyu	Luo	Mixed Series: Luo and Kikuyu	Masai
O	0·6882	0·6881	0·7145	0·7095
A_1	0·1113	0·1127	0·1077	} 0·1148
A_2	0·0661	0·0362	0·0435	
B	0·1343	0·1629	0·1342	0·1756
MS	0·2088	0·1010	0·1642	
Ms	0·3799	0·4068	0·3619	
NS	0·0841	0·1285	0·1124	
Ns	0·3272	0·3637	0·3614	
R_1 CDe	0·0654	—	0·0730	
R cDE	0·0645	—	0·0992	
R_2 cDe	0·6159	0·8174	0·5550	
R^0 cD^{u}e	0·0942	0·0474	0·0399	
r cde	0·1287	0·0415	0·2045	
R′ Cde	0·0313	0·0469	0·0142	
R″ cdE	—	0·0469	0·0142	

DISCUSSION

The ABO blood group frequencies of a large number of East African tribes have already been studied by Elsdon-Dew (1939). Readers who wish to obtain a general view of the distribution of the ABO groups in the region as a whole should consult that paper and especially charts 4 and 8. If the gene frequencies given in tables IV and XI of the present paper are interpolated in chart 4 their relationship to the rest of the region will be clearly seen as well as whether the differences from earlier data are statistically significant (on a basis of P=0·05). It should be noted, however, that we find a B frequency among the Luo significantly higher than that determined by Elsdon-Dew. His figures for ABO frequencies, based on the examination of 440 persons, are, of course, to be preferred to ours—or rather, the total observations should so be accepted as giving the best frequency estimate. For the Kikuyu, on the other hand, we find a significantly higher A frequency than Elsdon-Dew. Here, again, the combined results should give the best estimate. The Masai with their high B frequency appear unique in this part of Africa. Of Africans generally their ABO frequencies most

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resemble those of the Ankonde of Nyasaland who possibly contain an Asiatic strain. The high B frequency of the Masai cannot be explained in a simple manner as being derived from Egypt, since the Egyptians have a very high frequency of A as well as of B.

No previous determinations have been published of A_2 frequencies in East Africa, and indeed very few from Africa at all, but it is known, mainly from observations on American Negroes, that A_2 is about as common in Africans as in Europeans. Our observations confirm this.

The MNS results support the slowly growing mass of data showing that pure Africans generally have about equal M and N frequencies, and that the gene S is much rarer than in Europe and about equally divided between the M and N genes. The scattered data will shortly be collated and discussed by Mourant (1953).

The high P frequency found among the Kikuyu is similar to that found in all African populations that have been tested. The strength of P reactions varies widely from one individual to another in all populations, but in the Kikuyu as in other African populations the average strength of the P reactions is much greater than among non-Africans.

Twenty Luo were also tested for the Kidd or Jk^a antigen. All but one were found to be positive. Thus in this population as among West Africans the frequency of this antigen is much higher than among Europeans.

The Rh results are the most difficult to interpret, and especially those of the Luo. It is quite clear that the latter have a very high frequency of the chromosome cDe and a very low one (for Africa) of cde. However, though observed and calculated phenotype

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[B: bibliography - see also p. 59b]

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frequencies agree well, it cannot be said with certainty that all the C and E genes are, as assumed, in the respective combinations Cde and cdE; it is possible that the chromosomes CDe and cDE are present in the phenotypes CcDee and ccDEe. The Kikuyu Rh groups are easier to interpret. The chromosome cDe is still very abundant though less so than in the Luo, while cde remains rare.

The mixed series of specimens shows less extreme values for both cDe and cde than either of the pure series, suggesting that the extreme character of both of the latter series is in part an accident of sampling. Moreover, individual batches of specimens from different areas seemed to have characters of their own and, though these variations were scarcely significant statistically, it is possible that there is some heterogeneity of Rh constitution even within racial groups. Much more numerous tests must be done on both tribes before their Rh constitution can be clearly interpreted.

Taking all blood group systems into consideration, it is surprising to see how slight are the differences between the Nilotic Luo and the Eastern Bantu Kikuyu. From the present study and the results of Eladon-Dew (1939) the tentative conclusion can be drawn that the East African native population (apart from the Masai and other Hamitic tribes) is, on the whole, fairly uniform.

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[B. Wangaapby - see also p. 59a]

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